



Deep Underground Science & Engineering Laboratory (DUSEL)

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P5 Meeting
Stanford Linear Accelerator Center
February 21-23, 2008



Outline

- Overview
- Solicitation process, current status
- Preparing the experimental program
- MREFC process, status
- DUSEL planning: timelines, funding
- Final comments

Acronyms:

AD = Associate Director

ISE = Initial Suite of DUSEL Experiments

MREFC = Major Research Equipment and Facilities Construction funding line

MPS = Mathematical and Physical Sciences Directorate

NSB = National Science Board

OD = Office of the Directorate

PHY = Physics Division

R&RA = Research & Related Activities funding line



DUSEL Overview

- Joint initiative within NSF between Physics (lead), Engineering, and Geosciences
 - Biology currently serving in advisory capacity
- Science and engineering program driven by physics, being designed to accommodate a broad, evolving multidisciplinary program
- New opportunity for growth, diversity, inter-disciplinary research
- Addresses worldwide need for dedicated, extensive space at depth, for all programs, over multiple decades
- Intrinsically strong program for education, outreach
- Will enable new, long-term partnerships among disciplines, organizations: public, private, international
- Transformative, high-risk/high-reward, visionary facility & program
- #1 priority for new project start in Physics Division



Community Planning Activities

- Community Activities, Advisory Committee Reports
 - Bahcall report (2001)
 - Nuclear Science Advisory Committee (NSAC) Long-Range Plan (2002, 2008)
 - International Workshop on Neutrinos and Subterranean Science (NESS, 2002)
 - High Energy Physics Advisory Committee (HEPAP) Long-Range Plan (2003)
 - *EarthLab* (2003)
 - DOE 20-yr. Facility Plan (2003)
 - The Neutrino Matrix (Four APS Divisions, 2004)
 - Quantum Universe – The Revolution in 21st Century Particle Physics (2004)
 - *Deep Science* (2006)
- National Research Council, National Science and Technology Council Reports
 - Connecting Quarks to the Cosmos (2003)
 - Neutrinos and Beyond (2003)
 - Physics of the Universe – A Strategic Plan for Federal Research at the Intersection of Physics and Astronomy (2004)
 - Revealing the Hidden Nature of Space and Time (*EPP2010*, 2006)
- Additional activities, sub-panels: NuSAG, DarkMatterSAG, workshops



Why DUSEL?

“A national underground laboratory offers the United States some vital scientific opportunities that will affect a number of important international efforts and provide a center in the United States for some of the most exciting physics at the beginning of the 21st century.”

- » From “Neutrinos and Beyond”
- » National Research Council Report, 2003

Now, time for community to detail the case



DUSEL Research Program

- Multidisciplinary, diverse suite of experiments:
- Life at Depth
 - Study of subsurface biosphere, isolated underground life forms
 - Life at high temperature, pressure, microbial activity at low respiration rates; associated genomic features
 - Lower campus: platform to drill deeper – 12000ft (120°C)
- Rock at depth
 - Large scale rock mechanics, slippage mechanisms
 - Scale/stress/temperature dependence of rock properties
 - Drilling; excavation; tunneling; fracture
- Fluid flow and transport at depth
 - Applications include stability of water supplies, hazardous waste disposal, geothermal power, remediation of contaminated groundwater
 - Studies of rock/water interface; high pressure, chemical/thermal gradients, etc
- Mineral resources and environmental geochemistry



DUSEL Research Program

- Very low level counting facility, experiments
 - Low background, underground physics, cosmogenics
 - Potential applications to homeland security
- Science, technology and engineering innovation
 - Novel microorganisms, analytic techniques for geomicrobiology, drilling and excavation technology, environmental remediation, subsurface imaging, ...
 - Creation of pure crystals without cosmic ray induced “impurities”
 - Basic research in underground and mining safety
 - Excavation of very large openings at depth; rock fracture at depth
- Neutrino physics
 - Neutrino-less double beta decay
 - Solar neutrinos
 - CP violation, long baseline experiment
 - Neutrino mixing angles
 - Nuclear astrophysics, low cross section measurements
- Dark matter searches
- Proton decay
- Supernovae neutrino observations



DUSEL Selection Process

- Initiated at Town Meeting at NSF, March 2004
- **Solicitation 1 (S1):** define site-independent science scope and infrastructure needs; unify the community (awarded Jan 2005)
- **Solicitation 2 (S2):** develop conceptual designs for one or more sites (two awarded, Sep 2005)
- **Solicitation 3 (S3):** technical design for an MREFC candidate (one awarded, Sep 2007 – Homestake, U.C. Berkeley)

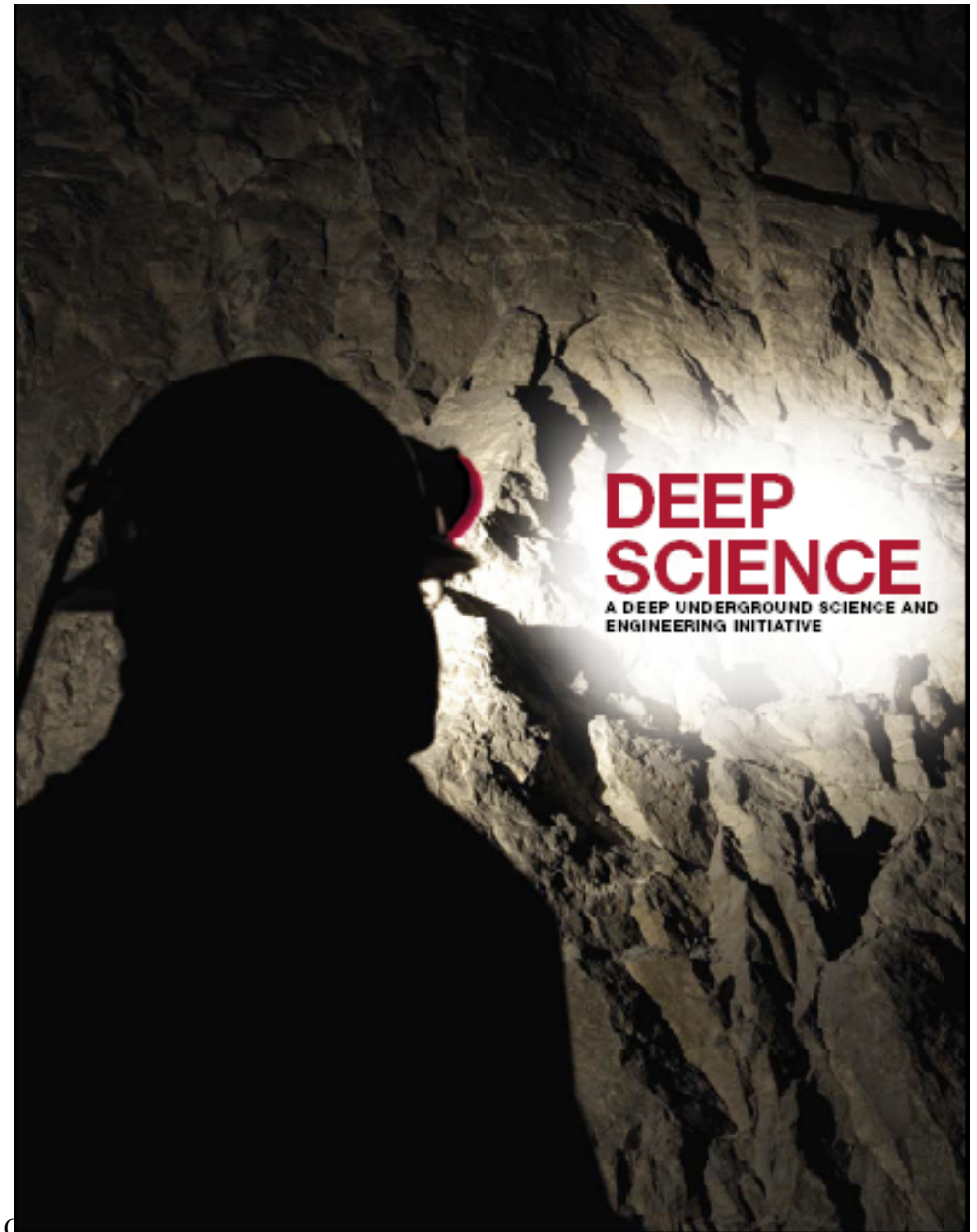


S1 Report: *Deep Science*

Recommendations:

1. Strong support for pursuit of deep underground science
2. Develop cross-agency Deep Science initiative in the US
3. Construct a flagship Deep Underground Science and Engineering Laboratory

Report available at www.dusel.org





Solicitation 3

- Third solicitation (S3) published September 29, 2006
- Open competition
- Proposal deadline 09 January 2007, four proposals received
- Goal was to select single site, if at least one is considered to be viable, to develop technical design of facility. Prepare for MREFC consideration.
- Chosen site would receive up to \$5M award per year for up to three years via cooperative agreement for design development
- Review process designed with great care. Proposals comprehensively reviewed by broad, multi-disciplinary 22-member expert panel.
 - Independent cost analyst contracted by NSF
- Review included site visits & reverse site visits

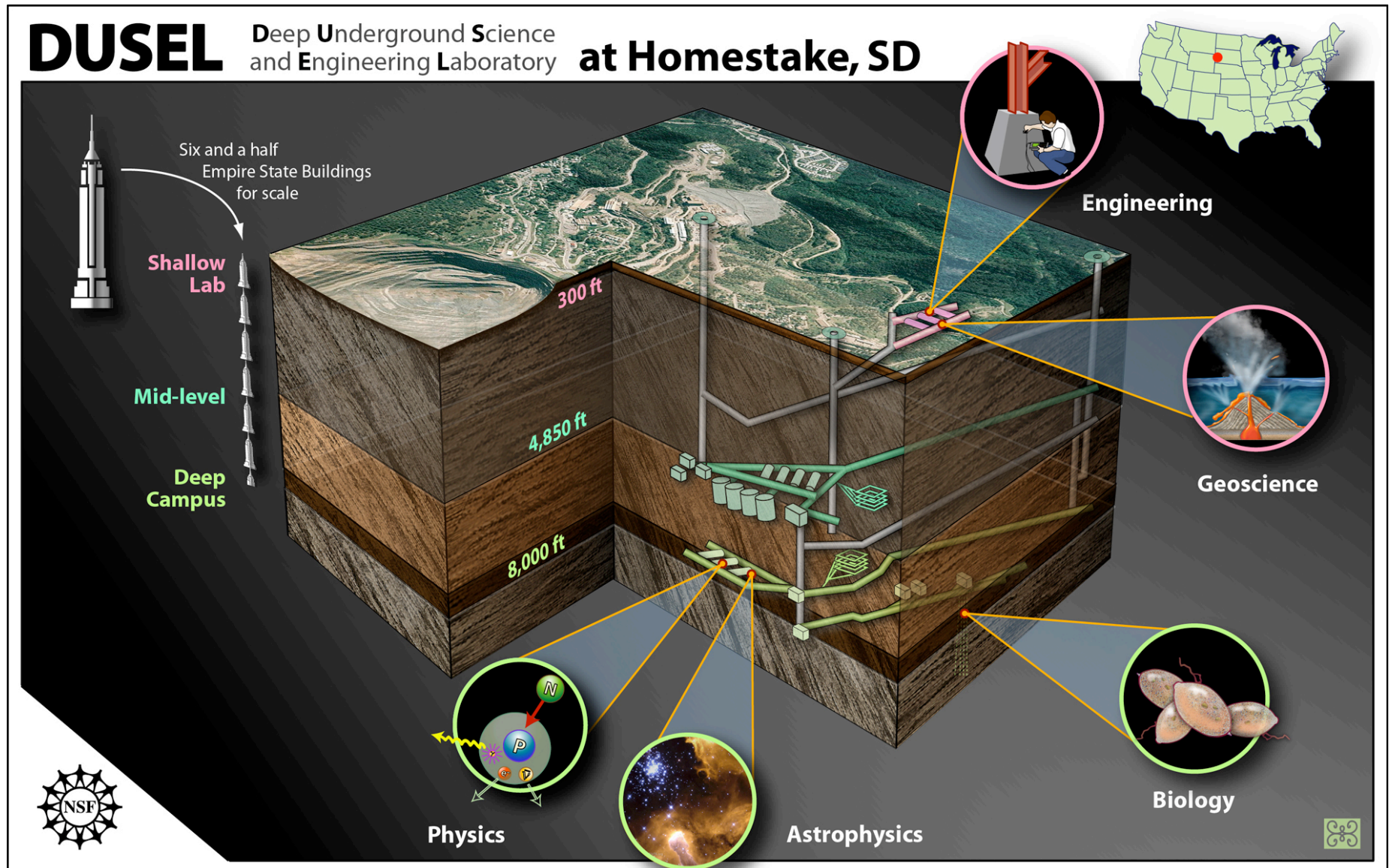


S3 Results

- Panel unanimously voted by secret ballot to recommend the Homestake proposal to the NSF for funding.
 - Option to vote for “no site” was not exercised by any Panelist
- NSF concurred. Decision, process vetted by Director’s Review Board, July 3, 2007.
- Announcement made Tuesday, July 10.
- Award made to University of California, Berkeley in September 2007. Total award \$15M over 3 years.
- Update on DUSEL status presented to Committee on Program and Plans of the National Science Board, October 3, 2007.
- DUSEL Community Town Meeting – 2-4 November ’07, Washington
 - See Lesko talk



DUSEL at Homestake





Meeting in South Dakota

- Town Meeting with Delegations in SD 9/13/07
 - Organized by Senator Thune
 - Senator Johnson's office (ill) and Representative Herseth Sandlin also present
 - Attended by MPS AD (Chan), PHY PD (Kotcher) & Office of Legislative & Public Affairs (OLPA)
 - State senators, SDSTA, Board of Regents, university presidents, local business people, other stakeholders present
- Discussions on moving ahead with Homestake DUSEL
- Rapid City and Lead, NSF trip underground
- Intensity, breadth of support impressive



Moving Forward

- Selection of a site put DUSEL on new footing
- Planning activities now take on a focused, site-specific approach, targeted toward an MREFC bid
- Community support and interest is a (the) critical ingredient for seeing this project through to a launch



Preparing DUSEL

- Facility design is one critical component of the MREFC package; experimental program is another
- Resources required to realize both must be elucidated
 - Cost, schedule, staffing requirements, risks, etc.
- Additional solicitations in the series are being developed to accommodate this process



Solicitation 4

- Solicitation 4 (S4, in clearance): call for proposals to develop project plans for potential candidates for the ISE
- Design funds to address: what do you need to execute the experiment you propose?
 - Will include opportunity for limited, targeted R&D
- Open to all disciplines
- Up to \$15M total from Physics/MPS, over 3 years
 - Primarily for physics experiments
 - Additional \$0.5-1.0M from engineering
 - Approach to BIO, GEO being determined; will depend on proposals received
 - Independent of '08 DUSEL R&D (*more later*)
- Expect publication in spring '08.



Solicitation 5

- S4 provides design & development funds for experiments that might be included in ISE
- Solicitation 5 (S5): will call for proposals from which final selection of ISE will be made
- Must allow sufficient time to review, develop final MREFC package
 - Facility + experiments, interfaces
- Current plan has publication in winter '09
- Funding recommendations for both S4 & S5 will be obtained via peer review through NSF panels



NSF Approach to Facilities

- NSF is reactive to the research communities; is not mission oriented
- Initiative for new projects originate within the community
- Community also drives and shapes project's development
- Facility priorities established annually by NSF and National Science Board (NSB)
- NSB provides direction on the fraction of annual NSF budget that will go toward facility support

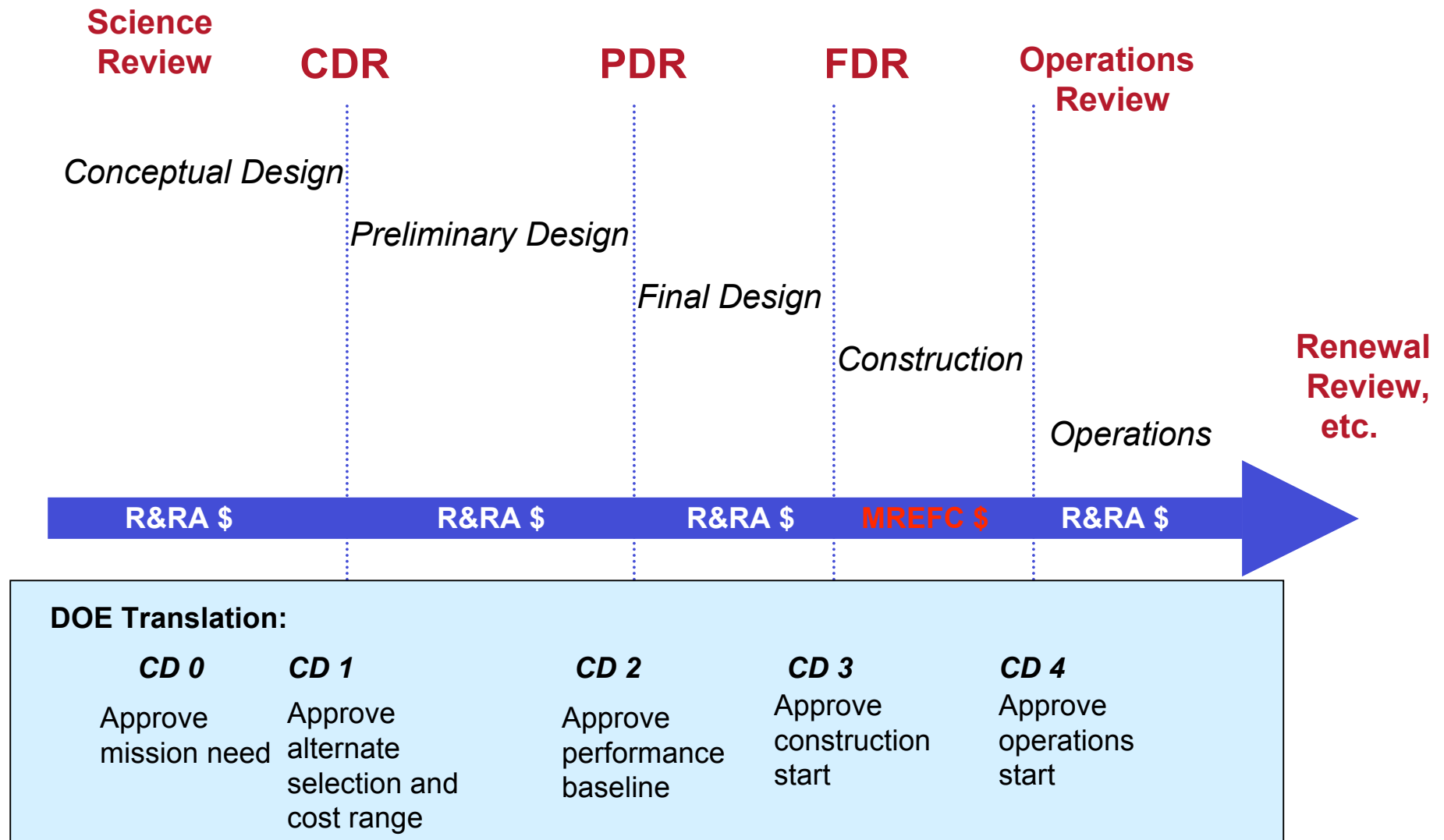


MREFC Review Process*

- Pre-construction planning proceeds through a sequential process of community development and NSF oversight and review:
 - Science goals
 - What science goals are the proponents trying to achieve by advocating this new facility?
 - Conceptual Design Stage
 - Description of functional requirements, top-down parametric cost estimates, rules of thumb for risk and schedule estimation, first estimates of operations \$
 - Preliminary Design Stage (or “Readiness Stage”)
 - Site-dependent description of all major functional elements, bottom-up cost estimates, algorithmic risk assessment, schedule derived from Project Mgt Control System, partnerships, refined ops \$ est.
 - Final Design Stage (or “Board Approved Stage”)
 - Interconnections and fit-ups of functional elements, refined cost estimates based substantially on vendor quotes, construction team substantially in place.



NSF Pre-Construction Planning Process





Example Timeline





Budget evolution

Project evolution

Oversight evolution

Conceptual Design Stage

Concept development – Expend approximately 1/3 of total pre-construction planning budget

Develop construction budget based on conceptual design

Develop budget requirements for advanced planning

Estimate ops \$

Readiness Stage

Preliminary design

Expend approx 1/3 of total pre-construction planning budget

Construction estimate based on prelim design

Update ops \$ estimate

Board Approved Stage

Final design over ~ 2 years

Expend approx 1/3 of total pre-construction planning budget

Construction-ready budget & contingency estimates

Construction

Expenditure of budget and contingency per baseline

Refine ops budget

Funded by R&RA or EHR \$

MREFC \$

Conceptual design

Formulation of science questions

Requirements definition, prioritization, and review

Identify critical enabling technologies and high risk items

Development of conceptual design

Top down parametric cost and contingency estimates

Formulate initial risk assessment

Initial proposal submission to NSF

Initial draft of Project Execution Plan

Preliminary Design

Develop site-specific preliminary design, environmental impacts

Develop enabling technology

Bottoms-up cost and contingency estimates, updated risk analysis

Develop preliminary operations cost estimate

Develop Project Management Control System

Update of Project Execution Plan

Final Design

Development of final construction-ready design and Project Execution Plan

Industrialize key technologies

Refine bottoms-up cost and contingency estimates

Finalize Risk Assessment and Mitigation, and Management Plan

Complete recruitment of key staff

Construction per baseline

Proponents development strategy defined in Project Development Plan

Described by Project Execution Plan

NSF oversight defined in Internal Management Plan, updated by development phase

Merit review, apply 1st and 2nd ranking criteria

MREFC Panel briefings

Forward estimates of Preliminary Design costs and schedules

Establishment of interim review schedules and competition milestones

Forecast international and interagency participation and constraints

Initial consideration of NSF risks and opportunities

Conceptual design review

MREFC Panel recommends and NSF Director approves advance to Readiness

NSF Director approves Internal Management Plan

Formulate/approve Project Development Plan & budget; include in NSF Facilities Plan

Preliminary design review and integrated baseline review

Evaluate ops \$ projections

Evaluate forward design costs and schedules

Forecast interagency and international decision milestones

NSF approves submission to NSB

NSF approves submission to NSB

Apply 3rd ranking criteria

NSB prioritization

OMB/Congress budget negotiations based on Prelim design budget

Semi-annual reassessment of baseline and projected ops budget for projects not started construction

Finalization of interagency and international requirements

Congress appropriates funds

Final design review, fix baseline

Congress appropriates MREFC funds & NSB approves obligation

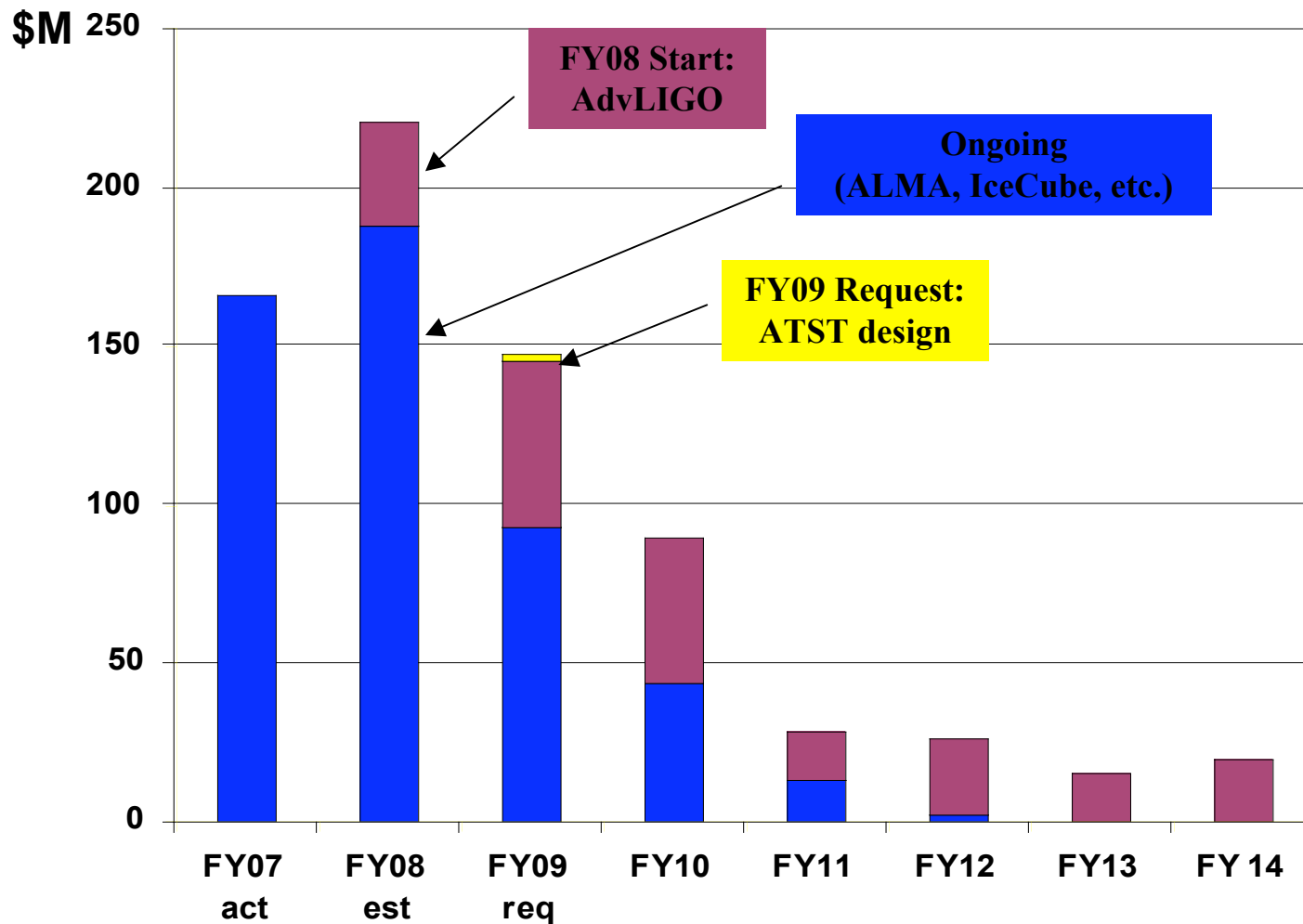
Periodic external review during construction

Review of project reporting

Site visit and assessment



MREFC Funding: Ongoing + FY08 Starts + FY09 Request





DUSEL Status in MREFC Process

- S3 site selection review played dual role as Conceptual Design Review for facility.
- DUSEL passed this requirement.
- Recommendation to enter Project Readiness phase being considered by MPS Advisory Committee (Witherell, Chair).
- Preparations being made for final discussion at April 2008 MPS AC meeting.
- Will then be considered by MREFC Panel (OD, ADs)



Working Model of DUSEL Timeline

- Spring 08: S4 published
- Summer 08: Peer review of S4 proposals
- October 08: S4 funds released (requires 09 funds)
- December 08: NSF Review of DUSEL
 - Facility + experiments
- Winter 09: S5 published, proposals for initial suite
- Spring 09: Peer review & selection of initial suite
- December 09: NSF Preliminary Design Review of DUSEL
- Spring 10: Presentation of DUSEL package to NSB
- FY12: earliest construction funding start



DUSEL Facility & Program Planning

- Planning assumes facility costs would be borne by NSF
- Partnerships with DOE & others will be sought & encouraged for ISE
- At this early stage, Physics Division uses following rough planning targets:
 - \$500M for initial phase MREFC, split evenly between facility and experiments
 - Not etched in stone – will be responsive to project plan, compelling nature of case, etc.
 - 7-8 year construction period, experiments interleaved as they are ready
 - Preliminary Design Review end CY09
 - Earliest construction start FY12



Long Baseline Application in ISE

- Responding to the community, a mega-module (50 kton or more) is being planned for inclusion as part of the initial suite
 - Includes excavation, instrumented detector
- Would establish a flagship, world-class program as part of initial research plan
- Costs will have to be carefully examined, vetted in context of rest of ISE.
- As with rest of DUSEL, partnerships matter greatly here
- As does the community voice



Funding Model for Operations

- DUSEL M&O will ramp up as facility takes shape & experiments are deployed
 - ~ \$5M/yr at beginning of construction to support existing operations
 - Plateaus to ~ \$50M/yr as lab moves toward full ops mode, ~ 2017
- MPS has agreed that facility M&O would be sole responsibility of PHY/MPS
 - Other Directorates asked to provide M&O support for their research programs only
 - Similar assumption for experiments supported by other agencies, sources
 - Cost-sharing details being worked out within Division, Directorate
- 50% rule in PHY (facilities/grant program) will be respected
- Model is coarse, used for planning purposes only
 - Project will produce final numbers that will be peer-reviewed, baselined



DUSEL-related R&D Funding

- NSF Physics Division encouraged submission of DUSEL-related R&D proposals for FY07
 - Targeted detector R&D for underground applications
- Joined by DOE HEP and NP
- Proposals were submitted to both agencies; reviewed, prioritized by joint DOE/NSF panel in March '07
 - \$3.1M (NSF) + \$0.6M (DOE) = \$3.7M FY07
- NSF Geomechanics & Geotechnical Systems Program also funding DUSEL-related R&D. Proposals reviewed in April '07, 3 awards made (2 collaborative), ~ \$900k total (over 3 years)
- Programs continuing in FY08



Final Comments

- Preparation of a PDR-ready package in December 09 is fastest reasonable pace
 - Complex facility, experimental program: cost + contingency, resource loaded schedule, staffing, risk and mitigation, environment, safety, E&O...
- This implies earliest construction funds from NSF in FY12
- As posed to us: can progress beyond design be made prior to this?
- **NSF responds to the community.** Accelerated or not, in order to push DUSEL forward effectively in this climate there must first be a sufficiently clear show of community support for it as a high priority component of its program.
- **The nature of the support from the science and engineering communities drive the future of DUSEL.**
- Lesko will provide other perspectives on timing, etc.